## \*\*\*\* STARPATH Inland & Coastal Navigation Workbook

For use with paper and electronic charts



Used successfully by more than 20,000 classroom students since 1978



## Inland & Coastal Navigation Workbook

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#### ANSWERS

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#### Tools of the Trade

These are the basics plotting tools used in marine navigation. There are many alternatives, of various designs, but these are the basics that will do the job. These are the most common by far, worldwide, on all vessels.

#### Dividers

Dividers are used to measure the distance between two points, and also to help align parallel rulers or plotters. There are several styles. Shown here is a type of "speed bow." You can interchange one of the points with a pencil lead for drawing circles of position or other arcs.

A "bow" is a tool that will hold its point separation once set, and it is set by a rotating knob in the center of the tool—as opposed to conventional dividers which are just pulled open or squeezed closed. A "speed" bow is one that you can pull open or close by hand without having to use the center knob. In other words, you can override the fine control of the center knob by firmly pulling or pushing on the legs themselves.

This particular model has become the dividers of choice for the vast majority of professional navigators worldwide because of its ease of use and accuracy. This economic model is called (appropriately) "ultra light dividers."



#### Parallel Rulers

This is a tool that lets you draw one line parallel to another, some distance away from it. To use it, align one edge of the rulers with the base line, and then holding down that side of the tool, move the other side to the location of the new line. If the new location cannot be reached in one step, then you "walk" the rulers across the page to the destination.

It takes a bit of practice to manipulate these without slipping, but after some practice it is quite easy. There are numerous styles and sizes of these. We recommend a simple design, clear plastic, 15 inches long.



#### Weems Plotter

An alternative to parallel rulers is a rolling tool called a parallel plotter, or more specifically, the Weems parallel plotter, named after its inventor. These are designed to roll without sliding, which they generally do fairly well, with little practice. Unfortunately, rolling plotters do not

work well near the edges of charts, or over folds in the chart. We always carry parallel rulers underway and use the Weems plotter whenever possible, but immediately switch to parallel rulers if need be. On a large chart table (or kitchen table!) many navigators (not all) find this tool faster and easier to use than parallel rulers.



## INSTRUCTIONS

#### Overview

These exercises are designed to help small-craft navigators hone their skills in both routine and special circumstances. They are practical exercises in chart reading and plotting, position fixing, dead reckoning, compass work, and the use of special publications such as Chart Catalogs, *Tide Tables, Current Tables, Light Lists,* Notices to Mariners, *Chart No. 1, Navigation Rules,* and *U.S. Coast Pilots.* We encourage mariners to solve the charting exercises using both paper charts and electronic charts, and to that end we provide instructions for downloading free electronic charts and software chart viewers.

The level of these exercises is about that required in the USCG Masters license exam for 100 GT, which in turn is about the same as that used in coastal navigation certification exams from the U.S. Sailing Association, American Sailing Association, Royal Yachting Association, and the Canadian Yachting Association.

#### **Paper Charts**

The exercises in this book that require a chart use NOAA chart No. 18465, Eastern Juan de Fuca Strait. This is one of several charts that NOAA prints in a "training chart" edition as well as the regular navigation chart. The training chart edition is frozen in time to about 1999, but is otherwise the same as the navigation chart, which is updated every few years. For training exercises, it is best to use the training chart version called 18465TR, so all details match the exercise text. The TR version is also available at chart dealers and from NOAA at a much reduced price over the current navigation chart edition. Most of the exercises, however, can be worked with either edition if you happened to have one already. Table 1 shows where and how you can purchase this chart.

Except for this paper chart that must be purchased separately, all other reference materials are provided in the Tables Selections, or they are available as a free download from the Internet. You also have the option to work the exercises with an electronic chart of 18465. The echart is free as are appropriate viewers as discussed below.

#### Terminology

All references to "miles" are nautical miles. Sometimes this is stated as "miles" other places as "nmi." One nautical mile is about 6,000 ft. (Exact is 1 nmi =1852m =(1852x100/2.54)/12 = 6076.115... ft.)

General phrases like "north of" or "due east of," etc, always refers to True directions, unless otherwise specified. Wind directions are labeled by the source of the wind, i.e. north wind flows from north to south, "sea breeze" blows from the sea toward the land. Waves and currents, on the other hand, are labeled with the direction they flow toward. Winds, waves, and currents are always true directions unless specifically noted otherwise.

An in-depth Glossary of Navigation and marine weather is available online at www.starpath.com/glossary. Please refer to the Glossary for new terms as needed.

Tab	Table 1. Where to order paper chart 18465 tr*			
Online	http://naco.faa.gov/ecomp http://starpath.com/18465			
Phone	1-800-638-8972 301-436-8301 Mon Fri. 8:00 a.m 4:30 p.m. Eastern Time			
Email	il 9-AMC-Chartsales@faa.gov			
Mail FAA, National Aeronautical Charting Office Distribution Division, AJW-3550 10201 Good Luck Road Glenn Dale, MD 20769-9700				
In Person Person Check nationwide list of official chart dealers at http://www.naco.faa.gov/agents.asp. There is also a list of chart dealers printed in every NOAA Chart Catalog				
* You can order directly with credit card or contact them with questions about shipping options. The chart needed is 18465tr. Eastern Strait of Juan de Fuca. Stress that you				

want the training chart version.

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#### Chart No. 1 Booklet

Several problems require use of *Chart No.1*, which is a NOAA booklet that explains nautical chart symbols and abbreviations. This is useful for questions relating to chart reading. A free printable copy of this publication is online. See www.starpath.com/navpubs. NOAA no longer prints the booklet but several commercial companies do. The printed book is about \$10 to \$15, available at navigation supply stores and online. Every boat should have a printed copy of this book onboard. You can work all the exercises using the free electronic download edition if you choose.

#### Navigation Rules Book

The section of exercises on "Rules of the Road" requires the *Navigation Rules*, which is a USCG publication that lists all the Rules. A copy should be on all vessels. It is required on U.S. Inland Waters (defined in the Rules!) for all vessels over 39 ft long. There is a free copy on line. See www. starpath.com/navpubs for a link to it. Printed copies (\$10 to \$15) are available at navigation supply stores and online. It is not an exaggeration to say this is the most important book in navigation.

#### **Using Electronic Charts**

If you intend to use electronic charting on your vessel, it will be excellent practice to solve many of these practice exercises using electronic charts in addition to the traditional solutions using paper charts. In principle you can get more accurate results with the echarts, once you have mastered the special tools available. A few tips and tricks are outlined below.

-	Table 2. How to Download RNC 18465*				
Step 1	With an Internet connection, go to www.starpath.com/18465				
Step 2Select Download eChart EditionStep 2Choose Save (file name is 18465.zip)and select a location you can easily find.					
Step 3Double click the file 18465.zip, and extract the files to a location of your choice that you can easily find.					
Step 4Open your charting software or viewer and insta the chart. Sometimes the process is called "reg istering the chart." In either case, you are just telling the navigation or viewer program where the chart file is located on your computer.					
* If you use the latest edition of the actual navigation chart (18465) and not the training chart edition (18465tr) there will be several slight differences, which are noted in the exercises.					

Electronic charts of US waters made by NOAA are free Internet downloads. Table 2 presents the Internet link and procedures. There are two basic types of echarts. One is a graphic image of the paper chart, called a Raster Navigation chart (RNC); the other is a vector format, which effectively tells the software how to draw the chart each time you use it. Vector charts are called Electronic Navigation Charts (ENC). For the exercises in this book the RNC format is best suited. The RNC chart looks exactly like the paper chart, because it is just a digital scan of the paper chart.

The RNC echart is a computer file that must be viewed in a specialized computer program, sometimes called "echart viewer" and sometimes "navigation software." The distinction between these two types is often that the former lets you do everything with the echart except display a live GPS vessel position. To work these exercises that is all you need, but if you have a full function navigation software program you can use your own program and thus benefit from getting to know it better by working these exercises. If you have not worked with echart software, then these exercises and a free viewer will be an excellent introduction to the process.

There are several options for free echart viewers. A selection is shown in Table 3. There are also numerous commercial echart navigation programs, and many include a time limited demo version. Consult your local navigation supply store for options, or search online for "PC navigation software."

The functioning of plotting and measurement tools in navigation software are often unique to the product, but there are some common factors. Examples of the use of



these functions to solve typical charting exercises are shown below. Most programs have good Help files linked from their menu bars.

#### To measure the Range and Bearing Between Two Points

This common application can be done with a dedicated *Range and Bearing tool*, or with the *Route tool*. Use the Route option by making a one-leg route from Point A to Point B. A typical sequence might be to left click the Route button, single left click point A, double left click point B, then right click the line to view Properties. If you end up with too many points, i.e. you single clicked the second point not double clicked, it does not matter. Just double click at some point to finish the "route" and then delete the extra waypoints. The procedure will be mastered with little practice. A dedicated Range and Bearing tool works the same way but without the risk of adding extra waypoints.

By zooming in on the chart before point selection you can get very precise measurements. Remember that buoys and lights are located at the positions of the small circles associated with their symbols.

#### To Plot a Bearing Line

Without a dedicated Range and Bearing tool, a bearing line can be plotted the same way using the Route tool. For example, to plot a bearing line to a lighthouse that was at bearing 227° click the Route button, then from any place near your approximate position (it does not have to be particularly close) left click the chart once to mark one point. Then move to the area of the lighthouse and carefully double left click the lighthouse symbol on the chart to mark one waypoint there—or as near as you can. Then zoom in the view (usually the + key) and move the last waypoint to precisely the lighthouse (just left click and drag the waypoint to the lighthouse).

Once the lighthouse point has been precisely positioned, turn on the Data Display option that shows the orientation of the leg of the route, then left click and drag the first waypoint (not the lighthouse one) while watching the bearing to the lighthouse in the data window till it reads 227. You do not care what the range is, just make it far enough away that it is beyond where you think you are. This way you can lay a precise bearing line on the chart. Later you can use that bearing line to cross with another bearing line, or circle of position, or depth contour, or range line, etc to form a fix.

Each of these bearing lines can then be saved, and once saved can be hidden from view until they are needed again. To do this, it is best to give the "route" a name of such as "Prob 4.6 — bearing to Lighthouse Pt." You do not have to name it to save it since they get automatically named in sequence, but, as in real navigation, it is best to give all waypoints and routes pertinent names, so they are more easily found in the library of data saved. When navigating to a waypoint, it is also much better to have a real name on it (i.e. Desmond Sands) as opposed to, say, "WP12, Route 25."

Dedicated Range and Bearing tools work differently in different software. A nice feature is one that lets you draw in the line at the desired orientation anywhere on the chart and then click and move the entire line without changing its orientation. These tools are effectively acting like parallel rulers. Some even let you digitally set the precise orientation and length from its properties window once you have made an approximate one.

#### To Plot a Circle of Position

Suppose you measured distance off of a place called Mead's Peak and found you were 0.21 nmi off the peak. Place a waypoint on the peak and then go to waypoint properties and make an alarm ring. In some software you can do this in any distance units you choose; in others you will have to convert to or from nmi. If the range ring requires meters, for example, you will have to convert 0.21 nmi to meters, which means entering 389 as the radius (0.21x1852 = 388.92).

#### For more Help or Training

Reference books and resources are listed in Appendix 1. Please check www.starpath.com/18465 for links to more options on getting help with these exercises, along with details and plots of many of the solutions. Training aids are available as well as links to navigation schools and navigation certification associations around the world that offer basic and advanced training in marine navigation. Links to local classes from US Power Squadrons and USCG Auxiliary are also provided.

#### **Magnetic Variation**

For all exercises that require magnetic bearings use a magnetic variation of 20° E.

We need to make this request because this is the value on the printed Training chart, which dates from 1998, whereas if you download the latest echart it would be more than 10 years old, and the variation will be different. To present consistent answers, we fix the variation at the 1998 value. In 1998, the variation was 19.8° E, which we are rounding to 20°E. This rounding to the nearest degree is standard procedure in most practical navigation circumstances, the only exception being actual compass adjustment measurements.

At print time, the latest edition of this chart is the 38th, dated May 2008 (Figure 1). This is 10 years older than the 32nd edition from 1998 (Figure 2). In 1998 the chart tells us the variation was decreasing at 6' per year, so at that time we would have expected the 2008 edition to have a variation of  $19^{\circ} 45'$  E -  $10 \times 6' = 18^{\circ} 45'$  E. In reality, the variation decreased faster than that, and the actual 2008 variation was  $17^{\circ}45'$  E, with a new estimate of the future decrease being -11' per year.

One lesson in this observation is that old charts could have the wrong variation, even after correcting for the indicated changes. In high latitudes such as Alaskan waters, this type of error could be very much larger.



**Figure 1**. Compass rose from an echart of 18465, made from the 38th edition of May, 2008. The variation is  $17^{\circ} 45' E (17.8^{\circ} E)$  with an anticipated decrease of 11' per year.

**Figure 2**. Compass rose from chart 18465 TR, made from the 32nd edition of August, 1998. The variation is 19° 45' E (19.8° E) with an anticipated decrease of 6' per year.

# EXERCISES

#### SECTION 1 — CHART READING

These exercises require some version of Chart No 1, as discussed in the Instructions. There is also a full version online, with a link from starpath.com/navpubs. Use the Light List or Coast Pilot Index from the Tables Selections to locate marks or regions if needed. Use magnetic variation =  $20.0^{\circ}$  E for all locations on this chart unless otherwise specified. Note that it might help to work the Coast Pilot exercises from the end of this Section first to become more familiar with the chart.

1-1. One tenth of a nautical mile is how many (A) meters? (B) feet? (C) What is the unit called that is about 0.1 nautical miles? (D) What are the dimensions of our chart (18465) in nmi?

1-2. What is the distance and magnetic bearing from buoy Y "R" to buoy Y "RA" marking the entrance into Rosario Strait shipping lanes?

1-3. What is the color of buoy Y "R"?

1-4. What letters or numbers are printed on buoy Y "R"?

1-5. What is the distance and true bearing from buoy R "2" at New Dungeness Spit to buoy R "4" just west of Port Angeles?

1-6. The buoy R "4" just west of Port Angeles marks an underwater shelf. What is the charted depth of the water (A) 200 yards NE of the buoy and (B) 200 yards SW of the buoy?

1-7. What is the distance and magnetic bearing from Brotchie Ledge Light to buoy "V15" SE of Race Rocks?

1-8. Trace out this route and figure the total distance around it taking all marks to port: buoy Y "S" (N of Dungeness Spit) to buoy C "1" at Protection Island to east end of Protection Island, to buoy Y "SA" to Minor Island Light to Hein Bank buoy "DH" to buoy Y "R" and back to buoy Y "S".

1-9. There is a buoy at Hein Bank labeled BR "DH". (A) What is the color of this buoy? (B) What is the purpose and instructions of the buoy? (C) Check out your answers in the Light List. Have we learned anything more there?

1-10. Looking at typical shipping lanes from buoy "S" to "SA", (A) what is the width of the inbound and outbound lanes? and (B) What is the width of the separation zone?

1-11. Looking at the shipping lanes north of Crescent Bay,

(A) What is the width of the inbound lane? and (B) what is the width of the inshore zone at Crescent Bay?

1-12. What would our compass read if we were running westward along the inshore zone, parallel to the inbound shipping lane?

1-13. What is the width of the Strait from Tongue Pt. on the US side to Beechey Head on the Canadian side?

1-14. What is the compass bearing from the East end of Ediz Hook to the entrance to Victoria Harbor?

1-15. (A) What is the Lat, Lon of buoy Y "PA" read from the chart? (B) What does the Light List give for its location?

1-16. (A) What is the distance and true bearing from 48° 08.42' N, 123° 15.65' W to 48° 12.42' N, 123° 15.21' W? (B) What is the nature of the bottom at the first point (southernmost)? (C) What is the bottom at the northern point? (D) What are "swirls"? (E) Roughly how much farther apart would these two points be if the lat of the north one was increased to 48° 12.43' N?

1-17. What is the Lat, Lon of the point 3.50 miles south of buoy Y "RA"?

1-18. The Light List describes a light called "Discovery Island Light." Can this light be seen from Trial Island? Explain.

1-19. How many "miles per handspan" to a chart with scale (A) 1:20,000 and (B) 1:500,000?

1-20. Referring to Chart Catalog No. 2, what is the chart number for Neah Bay at the far western end of the Strait (not shown on our chart)?

1-21. Referring to Chart Catalog No. 2, what one chart covers all of the Strait of Juan de Fuca?

1-22. What does it mean when the seaward end of a jetty is shown dashed, like this = = = = = = ?

1-23. There are 4 shipwrecks between Dungeness Spit and Green Pt. Call them A to D, headed SW from easternmost one. Parts (A) to (D) are: what are the water depth and distance offshore of each one?

1-24. There are 6 rocks along the NW shore of Protection Island. Five are the same, one is different. (A) What is the

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difference between these two kinds of rocks? How high does the tide have to be to cover (B) all of them? (C) five of them?

1-25. (A) What is the elevation of Smith Island as read from the Chart? (B) What is this elevation as discerned from the Light List? (C) What does the Coast Pilot tell us?

1-26. Read the notes on the chart (always a good idea) to answer these questions: (A) What does the green "NWR" mean on the NE shore of Protection Island? (B) What part of the chart has the most accurate (latest) soundings measurements? (C) What is the copyright status of NOS nautical charts? (D) Running our dingy along shore about 5 miles due east of Smith Island (not shown on the chart) we see a series of red flags and lights. What do they mean?

1-27. (A) What is the true bearing from the Smith Island Light to the FL G 4s light at Davidson Rock? (B) What is the distance between the two?

1-28. There is a rock shown about one quarter of a mile west of Smith Island. (A) What is the depth at the site of that rock? (B) When the tide height is about 0 feet in that area, describe what the water will look like around that rock and between it and the island.

1-29. On Kulakala Pt (48° 06', 123° 04') there is something marked "E COR HO." What is that?

1-30. Call this the "US Shore Route":

Waypoint Location

- 1 0.25 miles N of Crescent Bay buoy R"2"
- 2 Angeles Pt. buoy R"4"
- 3 New Dungeness buoy R"2"
- 4 Pt. Wilson buoy R"6"

What is the compass course and distance of leg (A)  $1 \Rightarrow 2$ , (B)  $2 \Rightarrow 3$ , (C)  $3 \Rightarrow 4$ ?

Note that buoy 4 is not on some of the echarts we use in the electronic version of the course, but you can plot it there at: Lighted Buoy "4" at 48° 09.48' N, 123° 28.24' W

#### Practice with the Coast Pilot

Use the Index at the end of the Coast Pilot selection to find locations or topics mentioned. In each case we are asking you to use the Coast Pilot to identify or clarify some feature of the chart or to answer more general questions about the waters shown on the chart. The page numbers listed in this mini index are those at the top of the coast pilot pages.

1-31. Under the word "Smith" near Smith Island there is a "(55)" printed on the chart. What does that mean?

1-32. What river enters the Strait at Low Point?

1-33. There is a 480-ft tower on Angeles Pt. Are there any lights on that tower?

1-34. Just off of Observatory Point there is a "(20)" printed on the chart. What does that mean?

1-35. With regard to Rules of the Road, do the Inland or International Navigation rules apply on the Strait of Juan de Fuca?

1-36. The Strait of Juan de Fuca is subject to a unique Pacific Northwest hazard called "deadheads." When are deadheads a particular hazard in this region?

1-37. What time of year is fog most likely at the western end of the Strait of Juan de Fuca?

1-38. How strong can the currents be in Race Passage? Hint: always check Coast Pilot as well as current tables when studying the currents of an area that is new to you.

1-39. What is the unique behavior of bell buoy R "2" off of New Dungeness Light?

#### SECTION 2 — COMPASS WORK

Give Lat, Lon answers to nearest tenth of a minute unless otherwise asked.

2-1. (A) What is the magnetic variation near Hein Bank in 1998? (B) What will it be in the year 2005?

2-2. The local variation is 19° E. The true course to our destination is 330 T. What is the compass course assuming no deviation?

2-3. A typical compass rose on a chart has 3 circular scales around it. The outer is true in degrees, the middle is magnetic in degrees, what is the inner most scale represent?

2-4. Question on "boxing a compass." North is true course000 or 360; East is 090. (A) What is SE (called southeast)?(B) What is W-SW (called west southwest)? (C) What is NE x E (called northeast by east)?

2-5. A sample deviation table	(from <i>Bowditch</i> )
-------------------------------	-------------------------

Compass heading	Deviation	
000°	10.5° E	
045°	20.0° E	
090°	11.5° E	
135°	1.2° W	
180°	5.5° W	
225°	8.0° W	
270°	12.5 ° W	
315°	6.8° W	

Hint: For general use of deviation tables of this type, it will be easier if you first construct a table in terms of Magnetic heading. For practice: Compass Deviation Magnetic 010.5° 000° 10.5° E ? 015° ş 030° ş ? 045° 20.0° E 065.0° .. ••• .. .. .. 315° 6.8° W 308.2° 330° Ş ş 345° ç ? 360° 10.5° E 010.5°

(A) Fill in the missing parts of this table by interpolation. [See Notes on Interpolation in Appendix 2.]

Consider that the local variation is  $5^{\circ}$  W. What compass course would you steer to make a true course of (B) 340 T, (C) 033 T, (D) 152 T.

2-6. Using the deviation table of problem 2-5, and a local variation of  $12^{\circ}$  E, what is the true course you are steering if the compass reads (A) 335 C, (B) 032 C, (C) 317 C, and (D) 285 C?

2-7. If you reason through these various problems on conversions you will have more practice than you will likely ever encounter again. Solve for the unknowns marked by X and Y in each case. In part (A), for example, the true heading is known from the chart, and the compass is known from reading the compass, and the variation in the area is known from a chart. The problem, then, is to figure the proper magnetic heading and compass deviation. This type of problem is best solved using a TVMDC diagram and then filling in the blanks.

	True	Mag	Comp	Dev	Var
(A)	280	Х	296	Y	16° W
(B)	Х	014	Y	5° E	21° E
(C)	007	Х	354	8° W	Y
(D)	Х	276	276	Y	10° W
(E)	114	093	Х	5° W	Y
(F)	138	Х	138	Y	4° E
(G)	Х	006	Y	0°	21 ° W
(H)	049	Х	028	0°	Y
(I)	Х	355	351	Y	17° E

2-8. Hein Bank lighted buoy "DH" bears 310M and Smith Island Light bears 047M. (A) Are you in the shipping lanes? (B) What is the charted depth at your location? (C) What is your Lat/Lon? (D) What is the course and distance from there to the east tip of Protection Island?

2-9. Sailing just east of Dallas Bank, McCurdy Pt. bears 098 M, Beckett Pt. bears 161 M, and Protection Island tank bears

206 M. (A) What is your Lat/Lon? (B) What is the distance to McCurdy Pt? (C) What is the charted depth? (D) from there, what is the range and bearing to Pt. Wilson buoy R "6"?

2-10. You are headed straight toward Pt. Wilson Light on magnetic heading 100 M and McCurdy Pt. bears 150 M. What is your Lat, Lon?

2-11. On a rhumb line course from Pt. Wilson buoy R"6" to New Dungeness buoy R "2," what will be the magnetic bearing to the tank on Protection Island when you are half way there?

2-12. Following US Shore Route of problem 1-30, (A), (B), (C) are choose an appropriate magnetic bearing sight that would mark the approximate halfway point of each leg (1 => 2), (2 => 3), (3 => 4). Choose a landmark that is near the beam at that location. Give the name of the mark, the bearing to it, and briefly outline your reasoning for choosing it over others that might be possible. Note you can use the Coast Pilot to help with descriptions of places you do not know from direct experience.

2-13. You are in Puget Sound where the magnetic variation is 21° E. Your compass course is 285, and it has no deviation on this heading. The sun is setting dead ahead. (A) What is true bearing of the setting sun relative to due west? (B) Now a strange question: What time of year must this be?

2-14. Steering course 075M from New Dungeness Spit buoy R "2," you measure a radar range of 4.5 miles at relative bearing 045R to the north tip of Protection Island. (A) What is your Lat/Lon? (B) Are you in the shipping lanes? (C) What is the charted depth? (D) What are the main contributions to the uncertainty in this position?

2-15. Sailing on course 070 M along the inshore zone, north of Crescent Bay, you make a radar observation of range and bearing to Observatory Pt., west end of Freshwater Bay. You get 3.40 miles at a relative bearing of 066 R. (A) What is your Lat/Lon? (B) How far outside of the shipping lanes are you? (C) What is the range and bearing to Tongue Pt. from your position (just aft of the beam)? (D) There is a purple wavy line in segments shown near your position. What does that signify?

2-16. Your course is 110 T, abeam Sooke Bay on the Canadian inshore zone. The radar range and bearing to Otter Point (on your port quarter) is 2.7 miles at 221 R. (A) What is your Lat/Lon? (B) What is the magnetic bearing to Sheringham Pt. Light from your position? (C) What is the magnetic bearing to Race Rocks Light (Fl 10s)?

#### SECTION 3 — SPEED, TIME, AND DISTANCE

plus some related issues in chart navigation.

3-1. Convert the following to decimal hours (i.e. 1h 30m = 1.50h): (A)3h 20m, (B)12h 54m, (C)2h 18m, (D)0h 38m, and (E)1h 5m. Convert the following to hours, minutes, and seconds (i.e. 1.57h = 1h+0.57\*60m, etc.): (F)2.45h, (G)12.79h, (H)2.09h, (I)0.38h, and (J)1.73h.

Figure these time differences and sums. Use "today", "tomorrow," or "yesterday" as needed to describe the final time you get. Notation is 1205 = 12:05 = 12h 05m.

(K) 1934 - 0722, (L) 2312 - 0432, (M) 2312 + 0355, (N) 1425 - 0043, (O)1232 - 2139, (P) 2209 + 0658

3-2. (A) To average 200 miles per day what must your average speed be? (B) If your speed is 5 kts, how far do you travel in one day (24 hours)?

3-3. A Pilot Chart says the current drift is 15 miles per day. What is its speed in knots?

3-4. If Port Townsend is 37 miles away, how long will it take to get there at 4 kts?

3-5. (A) If Neah Bay is 110 miles away how long will it take to get there at 5 kts? (B) How long will it take if the first 50 miles is at 7 kts, you stop for 2 hr and the last leg is at 4 kts?

3-6. You have traveled 55 miles in 9 hr, what was your average speed?

3-7. You travel 12 miles in 3 hr 40 min, what was your average speed?

3-8. On a measured mile course you time the run from beginning to end, it takes 14 min 30 sec for the mile, what was your average speed?

3-9. You hold a steady 7 kts according to your knotmeter for a measured mile. (A) How long should it take to travel the course? (B) If the actual time was 2 minutes longer, how many knots or fraction of a knot was your knotmeter off? (C) What was its per cent error? (D) If this knotmeter reads 4 knots, what is your actual speed?

3-10. You want to check your speed. In calm water you approach a floating object and start a stop watch when it passes the bow and stop it when it passes the stern. The time was 4 sec. Your boat is 35 ft. long. Hint: use the rule that boat speed in knots equals boat speed in feet per second times 0.6. (A) What was your speed? (B) If your time was in error by 1 sec, how much in error would your speed be?

3-11. If you must sail a rhumb line distance of 18 miles to weather by tacking back and forth across the rhumb line, how long will take at 6.0 knots?

3-12. You must tack to weather for a distance of 4 miles at 5 knots, then reach on course for another distance of 8 miles at 6 knots. How long will it take to get there?

3-13. Consider this route: Leave Sequim Bay Entrance at 11:44 AM, sail east at 6.5 kts SOG to round Violet Pt. of Protection Island, then turn north to Minor Island with an SOG of 5.0 kts for that leg, then west to Hein Bank buoy "DH" with SOG of 7.2 kts and then back south to Sequim Bay at 4.8 kts for this last leg. Parts (A) to (D) What are the distances, true courses, and time run for each of these 4 legs (each part has 3 answers)? And (E), when do you get back.

3-14. You are at buoy Y "SA" NW of Pt. Wilson and your destination is Brotchie Ledge Light across the Strait to the NW at Victoria Harbor. Assume the current is slack for the entire route (which is, in fact, never the case for this passage) later we re-do this with current corrections. (A) What is the rhumbline course and distance? (B) At 7 kts under power on the rhumbline route, how long will this passage take?

The following are a few sailor's questions. Think on these, and if you do not know how to work them, then just read through the answers and plot out the results to learn how to do these. These are fundamental matters for setting optimum sailing courses to weather.

(C) Sailor's question: assume the wind is steady from the northwest throughout the waterway for the time underway, and choose and plot a tacking route that will get you there. Assume you are tacking through 90°, which is equivalent to assuming you are sailing a true wind angle of 45°. After plotting the proposed route, figure the distance along it and the time it will take at a steady 7 kts.

(D) Plot the course with the minimum number of tacks and compare the time to sail it with a route that does not get more than about 5 miles off the rhumb line.

(E) A bit harder sailor's question: Do the same as in part (C), but assume now that we know ahead of time that the wind is a lot different in the vicinity of Victoria. Assume it switches to pure northerly whenever you are north of 48° 17' N and west of 123° 04 W. Choose the optimum route anticipating the wind shift, again compute distance and time to get there. Speed is again 7 kts in all wind conditions. Discuss the guidelines you used for meeting the new wind in the optimum manner (i.e. shortest time to get there)?

(F) Show how much you saved using the right tactics by also solving the time it takes when doing it as wrong as possible.... ie, sail off to the wrong side of the course and compute the time, taking into account the wind shift.

3-15. Leave Salmon Bank buoy G "3" close abeam and steer a steady course of 242 True from there across the Strait. Neglect current and leeway for this plotting exercise. (A) Where do you come ashore on the American side (Lat/Lon and landmark)? (B) What is the distance covered? (C) If you plot this route with a heading error of 1°, how far off will your answer be? (D) At an average speed of 3.2 kts for the first third of the trip, and 6.7 kts for the middle third, and 8.1 kts for the last third, how long will it take (hr and min)?

3-16. Your digital compass manual states that to calibrate your compass you must swing ship through 360°, uniformly (at constant speed) travel in a circle, taking at least 10 minutes to complete the circuit. Describe a way to do this by listing vessel speed, turning rate or step size, and then compute or plot the diameter of the entire path that you would be following according to your plan... or give any other method you can think of that will accomplish this and tell how to execute it.

3-17. I am traveling at 6.3 kts and I have 22.9 miles to go. How long will this take me?

#### SECTION 4 — DR AND PILOTING

4-1. It is nighttime and you are headed for Victoria Harbor. You are somewhere on the line created by the range of lights from Brotchie Ledge Light to the isophase 12-mile light near the Esquimalt Harbor entrance. Use a variation of 20° E for this problem. With a hand-held compass you measure the bearing to the Discovery Island Light to be 028 M. Locate your position along this range. (A) What is your lat/Lon? (B) Suppose now that this measurement was in error by 3° and the correct bearing should have been 025 M. Find your position from this bearing. What is your Lat/Lon? (C) How much was your first position fix in error?

4-2. In problem 4-1, instead of measuring the bearing to Discovery Island Light, you measure the bearing to the Trial Island Light to be 347 M. Use a variation of 20° E for this problem. (A) Locate your position along the range. What is your Lat/Lon? (B) Now again assume the compass was in error by 3° and the correct bearing should have been 344 M. What is your Lat/Lon? (C) How much in error was this fix due to the compass error? (D) Compare this to 4-1 result. What is the message?

4-3. *This problem is a charting exercise. It is not necessarily a prudent navigational maneuver, as we shall see.* You are in Kanaka Bay on San Juan Island. It is thick fog in the middle of the night. You need to enter San Juan Channel on the other side of the peninsula. You choose to use your depth sounder to follow the steep drop off in depths, down and around the Salmon Bank buoy G "3."

(A) Verify that the 20 fathom contour will be a good guide to the region of the buoy.

(B) What will be your approximate magnetic course as you head toward Eagle Pt?

(C) If your log reads 707.0 as you leave Kanaka Bay, approximately what will it read as your depth contour course curves around to the south?

(D) As the contour begins to turn south, you confirm that your log reads close to what you expected (what does this signify?) so you decide to ease into the 10 fathom line. How close will this take you to the G "3" gong buoy?

(E) Will you be able to hear the gong as you pass? Explain.

(F) At the southern tip of the bank you turn north to follow the 10 fathom line up toward the channel, but as you proceed north, you very quickly notice that you cannot maintain 10 fathoms, and in a few minutes the depth is 60 fathoms? What is the likely explanation of this and what is the message?

(G) What would be your recourse in this circumstance, we still cannot see anything and the depth sounder is our only electronics.

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4-4. Because you lost track of the 50 fathom line in the last situation, you decide to check your depth sounder. You are now somewhere just west of Buoy BR "DH" on Hein Bank. Discovery Island Lt bears 286 M. Your depth sounder shows 26 fathoms. Log = 07468.2, you head directly toward the light. When the depth sounder reads 30 fathoms a while later, the log reads 07472.8. Checking the chart, does it appear that the depth sounder is working properly? (Assume there is no tide)

4-5. Practice with DR and course plotting: You are 0.2 nmi south of G "V15" off Race Rocks and your log reads 5123.4. Lay out the course directly toward the Y "VH" Racon buoy south of Victoria Harbor. (A) What is the magnetic heading of this course? Now sail on this course for exactly 2.2 miles. (B) What will your log read now? (C) From this point what is the bearing to the light at Bn 2 F R in Pedder Bay? (D) What is the bearing to the Trial Island Lt? Now sail on toward the Racon Buoy until the Trial Island Lt bears 046 M. (E) What will the log read now? (F) How far are you from the Racon Buoy?

4-6. You plan to continue sailing, but starting from the same point where you left off in the last problem, you change course to 080 M, and sail on this new course until the log reads 5142.4. Now, take a bearing to Hein Bank Buoy BR "DH." (A) What will this bearing be? Now change course to 226 M and sail for 5.5 miles, and then turn and head directly back for the Y"VH" Racon Buoy. (B) What is your compass heading back on the last leg? (C) What is the distance back to Y"VH" from this last turn? (D) What will your log read when you arrive at a point a half mile before the buoy?

4-7. More DR plotting: Starting point is the G "3" Buoy on Partridge Bank. Depart at 10:04 at 7 kts on course 004 M. At 10:30 change course to 249 M and reduce speed to 4 kts. At 11:15 change course again, returning to G "3" directly at a speed of 10 kts. (A) What will be the bearing back to the buoy at 11:15? (B) What is the estimated time of arrival back at the buoy?

4-8. Plot the DR track on your chart that corresponds to the following section of the log book. Subtract successive log readings to find distance run on each leg; it is more accurate than speed x time.

Time	Log	Course	S-kts	Comments
12:00	5651.0	182 M	6.0	Fix at 48° 28.6'N 122° 46.2' W
12:38	5654.8	222 M	6.5	Turn to clr Dav Rk
13:12	5658.5	274 M	7.0	Head towards Haro
14:30	5667.6	205 M	7.0	Head into Strait
15:30	5674.6	205 M	7.0	Position Fix here

(A) What is the latitude and longitude of your DR position at log 5674.6?

(B) You do a position fix at log 5674.6 and find that your true position at that time is  $(48^{\circ} 20.2' \text{ N}, 123^{\circ} 10.8' \text{ W})$ . What is the distance between your fix and your DR position at log 5674.6?

(C) What is the direction from the final DR position to the final fix position?

(D) Assume that your DR was wrong because you were in a current that set you off your DR track. Your first fix was at 12:00, the second at 15:30. What was the set (true direction) and drift (speed) of the current? The procedure is to assume that during the time you sailed your DR track, the water moved from your final DR position to your final fix position, thus accounting for the discrepancy.

E) In practice, could you conclude from this work that the "current" you found this way was the true water current over the course you sailed? Explain.

4-9. If the tide tables tell us that low water is 2.0 ft, and the charted depth is 2 fathoms, what is the depth of water in feet at low water?

4-10. You are crossing Haro Strait from East to West and are approximately 1/2 mile south of Beaumont Shoal buoy "VD". Your intention is to approach through Baynes Channel and anchor in Cadboro Bay. You know from the Canadian local notice to mariners that the north lighted buoy BY "VK" guarding Fulford Reef is "off station" and unavailable. To avoid the reef, you set up a danger bearing. Giving the deck watch a hand-bearing compass, you tell them that the QG Light on Cadboro Pt. Should bear : "No more than" or "No less than" this bearing \_\_\_\_\_\_. Choose the proper bearing restriction and give the bearing. (Assume you want to pass 0.2 nmi north of the proper location of buoy VK.)

#### SECTION 5 — MORE DR AND PILOTING

Note that problems 5-1 through 5-5 do not give an initial position, only an approximate location. To work these, estimate a position in the area based on what you know, lay off your course, and go on from there.

5-1. Running fix. You are sailing north from Rocky Point on the Miller Peninsula. Your heading is 332M. When your log reads 552.4, you take a bearing to the R"2" Bell Buoy off Dungeness Spit, which is 297 M. You continue on course and later take a second bearing of the Bell Buoy which is then 262 M. The log now reads 556.4. Advance the first LOP to the second to find your position by running fix. (A) How far are you from the Buoy R "2"? (B) What is your distance off the northernmost point of the Dallas Bank 10 fathom depth contour? (C) What is the water depth where you are?

5-2. Bow angles. In problem 5-1 (A) What was the angle on the bow of the R''2'' Buoy at log = 552.4? (B) What was the angle on the bow at log 556.4? (C) What was the distance run between sights? (D) What does this tell you about your distance off the Buoy at log 556.4? (E) Does this agree with 5-1?

5-3. Bow angles. You are sailing course 062 M off Victoria Harbor. You do not have a chart of the area (big mistake). The Victoria Harbor Light bears 020 M when the log reads 1672.5. (A) What is the angle on the bow of the light? (B) What will the bearing of the light be when you have doubled the angle on the bow staying on your original course? (C) Watching the light and your log, you note that the log reads 1674.2 when the light bears 338 M. What is your distance off the light?

5-4. Running fix. Referring to problem 5-3, now using the chart, verify your results by plotting and advancing the first LOP to form a running fix with the second.

5-5. Running fix, two targets. You are sailing course 050 M near Sheringham Pt. at speed 7 knots. It is foggy but calm. All you can see is Sheringham Pt. Light. You note that it is exactly on your beam at 18:55. (A) What must its magnetic bearing be at 18:55 if it's on your beam and you know your course heading? (B) You continue east on the same course at the same speed. The fog clears and you can just see the light at Race Rocks well off to starboard at 19:19, and it bears 080 M. How far have you traveled?

(C) Advance the first LOP to the second to find your position at 19:19 by running fix. What is your Latitude and Longitude? (D) What light should you be seeing dead ahead?

5-6. Reserved.

5-7. If your compass had an error of 12° that you did not know about, how far off course would you be after traveling 45 miles? Use 6° rule, or plot it out to scale.

5-8. Vertical angle. You are approaching Race Rocks Lt. With a sextant you measure its height above the water to be 1° 15′. How far off the light are you?

5-9. Vertical angle. You are north of the tower at Angeles Pt. Again, you use your sextant and measure its height above the water to be 2° 45'. What is your distance from the tower?

5-10. Bow angles. You are approaching the 120-foot-high Donaldson Island near Sooke Inlet. Your course is 272 M, the island bears 312 M when the log reads 6366.5. (A) What bearing to the island should you look for in order to double this angle on the bow? Continuing on a steady course, the log reads 6368.2 when the bow angle to the island has been doubled. (B) How far off the island are you now? (C) How close will you pass Otter Point if you hold a steady course?

5-11. Running fix. Your estimated position is 2 miles southeast of Beaumont Shoal Buoy (YB "VD"), and your course is 000 M. The buoy bears 280 M when your log reads 6672.3, and after sailing for 1.5 miles on course 000 M, the Beaumont buoy bears 226 M. What is your latitude and longitude at the time of the second bearing?

5-12. Running fix. You are sailing on course 042 M at speed 6.0 kts. At 18:40, the Smith Island Lt bears 104 M. At 19:10, the Smith Island Lt bears 132 M. What is your latitude and longitude at 19:10?

5-13. As you sail west out of the Strait of Juan, you can clearly see the highest point behind Murdock Creek bearing 218 M. You measure it's height with your sextant and get 2° 20'. What is your latitude and longitude?

5-14. Running fix. You are SW of buoy Y "R" sailing course 085 T at 6.0 kts. The buoy bears 043 T at 1235, and then 341 T at 1255. (A) How far off the buoy are you at 1255 assuming no current? (B) Same question assuming the current is 2.0 kts toward 295T and (C) same question with current = 1.0 kts due south?

5-15. Same question as 5-14, all three parts, but now assume there is in addition a strong northerly wind which gives you a leeway of some 7°. A, B, and C, give the distances off the buoy.

5-16. Running fix. You appear to be directly north of the Ediz Hook Lt [Fl G (2) W 10s] and you estimate your distance off the light as 2.5 miles. You then sail eastward at 048 M for 3 miles, then change course to 088 M and sail for 4.5 miles. Change again to course 022 M and sail for another 3.2 miles. Now you see the New Dungeness Lt which bears 084 M. (A) Advance your first LOP to the second one to find your running fix. (Latitude and Longitude) (B) From this position work backwards to find out what your actual distance off the light was when you estimated it to be 2.5 miles.

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#### SECTION 6 — LIGHTS and BUOYS

6-1. Your height of eye above the water is 9 ft. The weather is clear and the seas calm. What is the maximum range you could see (A) Race Rocks Light and (B) New Dungeness Light? (C) Does the Light List and the chart agree on the nominal ranges for these lights?

6-2. According to the Luminous Range Diagram, what is the Luminous Range of a 26-Mile light (Nominal Range = 26 mi.) when the prevailing atmospheric visibility is (A) 5.5 mi., (B) 1 mi., and (C) 500 yds.? Use the diagram on page xxxix of Light List insert.

6-3. According to the formula for Luminous Range given in the text, what are the answers to 6-2 (500 yds. = 0.25 mi.)?

6-4. From the top of a mast 49 ft above the water line, how far could you see the Race Rocks Light if the atmospheric visibility was 5.5 miles?

6-5. In the US and Canadian Light Lists for this chart region, you see a prominent light labeled Albert Head Light (48° 23.2' N, 123° 28.6' W). (A) Identify this light on the Chart. (B) What is the message? (C) What do you do when you run across a situation like this?

6-6. (A) From how far off can you see the Dungeness Spit Bell Buoy R''2'' if your height of eye is 9 ft. and the visibility is estimated to be about 5 miles? (Assume the height of the light on the buoy is 9 ft.) (B) How far could you see the light in clear weather?

6-7. You can see the Point Wilson Light while standing on the cabin top (height of eye about 15), but not from the cockpit (eye height about 8 feet). The water is calm, and it is a clear night. Roughly how far off the light are you?

6-8. From how far off could you see Protection Island (A) in clear weather? (B) In an atmospheric visibility of 4 miles? Use height of eye = 9 ft.

6-9. How far can you see a 5-mile light in 5 miles of visibility?

6-10. (A) If the nominal range of a buoy light is not given on the chart or light list, what should you assume it is? and (B) more generally, how far off should you assume you can see a typical buoy light with no other information available?

6-11. A light is charted as Fl 4 sec, 27 ft, 19 M. I can see the light from the cabin top at an eye height of 12 ft, but not from the cockpit at an eye height of 7 ft. How far off the light am I?

#### SECTION 7 — TIDES AND CURRENTS

The general phrase "local time" usually means standard time in the winter and daylight time in the summer. In the region of this chart, it is PST (zone +8) and PDT (zone +7). The Nautical Almanac (not part of this course) lists the precise time when the systems switch. See www.time.gov.

7-1. What are the local times and heights in feet for high and low waters at Port Townsend on (A) Dec 2 and (B) July 14, and (C) September 17th?

7-2. The ocean is calm and no bad weather is forecast. You want to go dinghy exploring in the rocks in and around Aleck Bay on Lopez Island. You want plenty of water for exploring the entire vicinity. (A) What are the precise local times and heights of the evening high water at Aleck Bay on July 14<sup>th</sup>? (B) What will be the water depth at the rocks in the back bay area at that time?

7-3. There is a prominent house about 2 miles SW of Dungeness Spit visible from the water. The bearing to this house is 110M. Your depth sounder reads 90 feet. (A) Assume this is the charted depth at your location and figure how far off shore you are (off the coast line, not off the house). (B) Now assume the depth sounder is 1 foot below the water and the tide height is 13 feet at the moment. Now how far offshore are you?

7-4. Make an approximate tide height table for every hour or so throughout the day at Port Townsend on August 22<sup>nd</sup>.

7-5. The tidal data box on the chart refers to a place called Gardiner, Discovery Bay. What is the charted depth at the exact Lat/Lon given?

7-6. Find heights in feet and local times of lower low water and higher high water at (A) Crescent Bay (B) Mystery Bay, for September 10, 1999.

7-7. (A) What is the charted depth at the entrance to Sequim Bay? (B) Find times and heights of tide for midmorning low and evening high at Sequim Bay entrance for July 12<sup>th</sup>. (C) Using this information, what can you deduce about a good time to enter Sequim Bay with plenty of water beneath your vessel? (HINT: What is the most obvious concern one might have if wanting to venture into Sequim Bay?)

7-8. There is a bridge in Port Townsend, just out of sight of this chart, which is labeled to have a vertical clearance of 58 feet. The high tide at the bridge is currently 10 feet. What is the actual clearance under this bridge at this time?

7-9. If your sailboat has a mast height of 62 ft, when would be the correct time to pass beneath the bridge in problem 7-8 on July 14<sup>th</sup>?

7-10. (A) What is the difference between Mean Lower Low Water (used as the sounding reference for US waters) and Lowest Normal Tides used in Canadian Waters? (B) According to **Table 2** — **Tidal Differences and Other Constants**, in the Appendix, station 1243 Sidney, Haro Strait (48° 39' N, 123° 24' W) has a mean tide level of 7.1 feet, whereas station 1233 which is Turn Point on Stuart Island (48° 41' N, 123° 14' W) just 6.9 miles to the East has a mean tide level of 4.7 feet. Does this mean there is a permanent slope of the water between these two stations of about 2.4 feet? Explain.

7-11. (A) Mark the location of all current stations on your chart within 5 miles of Iceberg Point. (B) What is the nearest tide station to Iceberg Point?

7-12. What are the times and strengths of peak currents and slacks at San Juan Channel (south entrance) on November 11, 1999?

7-13. What are times and strengths of maximum currents and slacks at Rosario Strait on July 14<sup>th</sup>, 1999?

7-14. What are times and speeds of peak currents and slack water times at Lopez Pass on July 14<sup>th</sup>?

7-15. What is the duration of "slack water" (here taken to mean water with current of less than 0.5 kts) for the predawn slack period at Lopez Pass on July 14, 1999. With reference to problem 7-14, this is the slack at 0437 PDT that occurs between the 1.0-kt flood and the 3.3-kt ebb. (A) Give the durations and three PDT times, using our "slow water rule" given on pages 9-9 and 9-10 of the Course Book. When the current drops to 0.5-kt flood, when it switches to ebb, and then when it builds back to a 0.5-kt ebb. (B) Give same data using the official "Table 4, Duration of Slack" which is Figure 12.18-2 of the textbook.

7-16. (A) What are the times and speeds of maximum currents on July 20<sup>th</sup> at the San Juan Channel reference station?
(B) Correct these times for "Cattle Point" currents, substation No. 2171. (C) What is the range and bearing from Cattle Point Light to the Cattle Point current station?

7-17. What is the strength of the current at San Juan Channel on December 25<sup>th</sup> at 0125?

(Hint: apply the 50/90 rule)

7-18. (A) What are the average set and drift of maximum currents at Lopez Pass, subordinate station No. 1981? (B) Plot these directions on your chart.

7-19. (A) After the name of current substation No. 1966, W. Point, Whidbey I, there is a "<9>." What does this mean? (B) After the name of substation No. 2126, Sinclair Island, there is a "<43>." What does that mean?

7-20. You want to travel from a point one mile east of Decatur Island to a location one mile west of Rock Point on Lopez Island. It is August 11<sup>th</sup>, 1999. When should you depart to benefit from the ebb current moving south around the east side and later the flood current north around the west side of Lopez? The wind is light and your boat speed is only 4 knots.

7-21. It is pea soup fog and your estimated position is 1 to 3 miles south of Hein Bank Buoy. Your course is 110 T. You just noticed that your depth sounder went from 15 fathoms to 70 fathoms in less than 0.4 miles (ie in 4 min at 6.0 kts). Looking ahead to Eastern Bank you are approaching in this region, you decide to do some depth sounding navigation to home in on your position. You hold a steady speed of 6 kts and a steady course of 110 T. You confirm from the current tables that the current is about slack at this time. Here then is a list of measured depths you record (corrected for draft and tide):

Time	Depth (fathoms)	Time	Depth (fathoms)
1315	92	1345	11
1320	88	1347	20
1325	71	1348	52
1327	50	1350	52
1328	32	1355	52
1329	19	1400	60
1330	18	1405	66
1335	13	1407	50
1340	11	1408	30
		1410	20

(A) Where are you at 1410, Lat/Lon plus description? (B) If you carry on on this course, what will be the minimum depth ahead of you? (C) When will you reach that depth? (D) How accurate is this fix and how can we prove it?

### SECTION 8 — DR WITH CURRENTS AND OTHER PROBLEMS

For these current problems we define the following relative bearings: current "on the beam" means current points toward your beam, about 90° off the bow. Current "on the bow" means the current points to about 45° off the bow (stem) of the boat, current "on the quarter" means current points to about 45° off the stern. In these we ask for approximate answers using the tricks of given in the text, and then the "exact" answers which should be obtained by plotting the vector solution.

8-1. Current is on your port beam at about 2 kts. Your compass reads 200 and your knotmeter reads 6.0 knots. (A) What is your approximate COG? (B) Will your SOG be larger or smaller than your knotmeter speed? (C) What is your exact COG and SOG from plotting?

8-2. Current is on your starboard quarter at about 2 kts. Your compass reads 200 and your knotmeter reads 6.0 knots. What is your approximate COG?

8-5. You want to go across a large open area to your destination which you see on the horizon. You know there are currents present but have no idea what they are. You pass by a light house just as you start your crossing. That is, just as you enter the currents the light house is dead astern. Your destination is dead ahead and your compass reads 340. The back bearing to the lighthouse is 160°; it is dead astern.

After traveling some time you notice that the lighthouse is no longer dead astern, though your destination still lies dead ahead because it is so far away, and your compass course hasn't changed. Using a hand-held bearing compass you find the bearing to the lighthouse is now 135°. What compass course should you turn to to get back on track toward your destination? (A long problem with a quick and easy solution.)

8-6. Figure 8-1 shows 6 current stations describing the current flow in this region. Identify these in the list of current stations provided.



Figure 8-1. Southern end of Rosario Strait. Used for current prediction problems

8-3. Your knotmeter speed is 5.0 knots. You want to cross a current that you estimate is about 1.5 knots on your beam. How many degrees should you point into the current to track straight across the current?

8-4. Sailor's question: You are beating to weather in strong southerly winds on a port tack. You estimate that your leeway is 10°. There is a current flowing to the north at about 2 knots. Your compass reads 205 and your knotmeter reads 6 knots. (A) What is your COG? (B) If you know you tack through 90° in such conditions, what should the compass bearing to a windward buoy be if you intend to pass to weather of it when you tack?

We plan a trip from Deception Island (waypoint 1), westward to Colville Island, passing close abeam of the Lawson Reef buoy (waypoint 2) and the R2 bell buoy marking the 3-fathom shoaling (waypoint 3) and the Davidson Rk Light (waypoint 4). Assume you are in a kayak or small craft under power and anticipate a steady (knotmeter) speed of 3.0 kts.

(A) For starters, assume you leave Deception Island at 1000 PDT on August 8th. Predict the current (set and drift) you would expect halfway between each waypoint at the approximate time you would anticipate being there. Answer is 3 sets and 3 drifts.

(B) Describe the "ferry angle" you would use if needed to cross these currents on a straight line and estimate how much that would slow you down in the total transit time — first figure transit time at 3 kts assuming no current. What time would you arrive at Colville Island.

(C) What are your general conclusions about the current considerations in this passage.

(D) If you could make this trip any Saturday or Sunday in July or August, what day and starting time would be the most favorable for a trip over and back, spending at least 2 hours at Colville Island? Show your reasoning.

8-7. On Wednesday, July14, 1999, you depart the Puget Sound Traffic Lane Entrance buoy Y "S" (48° 12.4' N, 123° 06.6 W) at a speed of 4.5 knots. (A) Determine the set and drift of the maximum ebb that morning at the nearest substation, and (B) using those figures, determine a magnetic course to the Rosario Strait Traffic Lane Entrance Buoy Y "R" (48° 16.4' N, 123° 06.7' W). You are motoring and there is no leeway to be applied.

8-8 At 0915, you depart the New Dungeness Sand Spit Lighted Bell Buoy R "2" (48° 11.5' N, 123° 05.7' W) on a course of 090° M toward Dallas Bank & McCurdy Pt. You are sailing on a broad reach in calm seas making 6.0 knots through the water. At 1045, you find yourself close aboard the McCurdy Point Buoy R "4" (48° 08.7' N, 122° 50.7' W). What has been the set and drift of the current during the trip?

8-9. Using a net tidal current vector (which means you assume the current is the same over the full run of all entries), plot your estimated 1552 position from the following Deck Log entries, assuming the current is 1.1 kt @ 270° T.

Time	Log	Course	Wind	Remarks
1330	10.5	050°M	270° T @ 15 kts	Close aboard Y "VF" 48° 14.1' N, 123° 31.9' W
1430	16.0	110°M	270° T @ 15 kts	Jibed to Starboard Tack
1518	20.4	050°M	270° T @ 15 kts	Jibed to Port Tack
1552	23.5	050°M	270° T @ 15 kts	Since 1330 current has been constant: 1.1 kt @ 270° T

(A) From the 1552 EP, what is the range and true bearing to New Dungeness Light if there were no current present?

(B) What is this same range and bearing after you correct the DR for the set and drift?

#### SECTION 9 — ELECTRONIC NAVIGATION

9-1. Suppose you are following the US Shore Route of problem 1-30 reversed (4 to 3, 3 to 2, and 2 to 1) to the west starting at WP4 with your GPS set to automatically switch to the next waypoint when you get within 0.25 miles of the target. And suppose that somehow at WP 3 the GPS skipped WP 3 and set your next course to WP2. It is midnight and your speed is 8 knots. (A) What are some consequences of such a goof-up and (B) name two ways that this type of thing could be avoided. [This is, by the way, a true story].

9-2. Sailing from McCurdy Pt region, NW across the Strait into Haro Strait you must cross two sets of lanes. (A) Set up a fake route as just described that will guide you across these lanes. List the two waypoints for each route, and the XTEs that will mark the boundaries.... (B) Can you think of a way that would simplify this process if you did a lot of navigation in this region?

9-3. What is the typical accuracy we might expect from a GPS fix, without any differential enhancement? A.  $\pm 2$  ft, B.  $\pm 20$  ft, C.  $\pm 40$  ft, D.  $\pm 80$  ft.

9-4. What can be said about the relationship between vertical accuracy and horizontal accuracy of a GPS position? A. They are about the same, B. Vertical accuracy is only about half as good as horizontal accuracy, C. Vertical accuracy is about two times better than horizontal accuracy, D. There is no valuable way to make this comparison.

9-5. What is the most likely reason that a fix from a handheld GPS unit is not as good as it was just some time in the past? A. Batteries are low, B. A satellite is temporarily not transmitting, C. The relative bearings of the satellites you have been using are no longer as favorable as before, D. You have sailed into a region or moved the instrument in such a way that part of the sky is now blocked from view of its antenna.

9-6. You are sailing east (090T) south of Donaldson Islet (48.35N, 123.71W) at a speed of 5.7 kts. From the radar you take a range and bearing to the islet at 1300 and get 3.50 nmi at 321R (relative). (A) What is your lat and lon? (B) at 1400 you do it again and get 2.67 nmi at 235R. What is your new lat and lon? and (C) What was the current you were sailing in?

9-7. Sailing due west (270 T) at 12 kts, south of Donaldson Islet, you measure radar range to Donaldson Islet to be 3.20 nmi and at the same time *(within a few seconds)* the range to Monument Point on Beechey Head is 2.40 nmi. What is your lat and lon?

9-8. You are sailing on course 300 T, south of Donaldson Is, at a speed of 12 kts. At 1410 you measure the range to Otter Point near dead ahead and get 4.80 nmi. At 1413 you measure the range to Donaldson Is near the beam and get 1.10 nmi. (A) what is your Lat and Lon at 1413 if you *do not* take into account the times of the measurements? (B) What is your Lat and Lon if you plot this correctly as a running fix? (C) How much error was in method A?



This is the end of the sample.

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